Free Quark Searches

NODE=S027

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NODE=S027

Quark Production Cross Section — Accelerator Searches

NODE=S027C
NODE=S027C

X-SECT (cm^2)	CHG ($e/3$)	MASS (GeV)	ENERGY (GeV)	BEAM	EVTS	DOCUMENT ID		TECN
<1.3E−36	±2	45–84	130–172	e^+e^-	0	ABREU	97D	DLPH
<2.E−35	+2	250	1800	$p\overline{p}$	0	[1] ABE	92J	CDF
<1.E−35	+4	250	1800	$p\overline{p}$	0	[1] ABE	92J	CDF
<3.8E−28			14.5A	^{28}Si–Pb	0	[2] HE	91	PLAS
<3.2E−28			14.5A	^{28}Si–Cu	0	[2] HE	91	PLAS
<1.E−40	±1,2	<10		$p,\nu,\overline{\nu}$	0	BERGSMA	84B	CHRM
<1.E−36	±1,2	<9	200	μ	0	AUBERT	83C	SPEC
<2.E−10	±2,4	1–3	200	p	0	[3] BUSSIERE	80	CNTR
<5.E−38	+1,2	>5	300	p	0	[4,5] STEVENSON	79	CNTR
<1.E−33	±1	<20	52	pp	0	BASILE	78	SPEC
<9.E−39	±1,2	<6	400	p	0	[4] ANTREASYAN	77	SPEC
<8.E−35	+1,2	<20	52	pp	0	[6] FABJAN	75	CNTR
<5.E−38	−1,2	4–9	200	p	0	NASH	74	CNTR
<1.E−32	+2,4	4–24	52	pp	0	ALPER	73	SPEC
<5.E−31	+1,2,4	<12	300	p	0	LEIPUNER	73	CNTR
<6.E−34	±1,2	<13	52	pp	0	BOTT	72	CNTR
<1.E−36	−4	4	70	p	0	ANTIPOV	71	CNTR
<1.E−35	±1,2	2	28	p	0	[7] ALLABY	69B	CNTR
<4.E−37	−2	<5	70	p	0	[3] ANTIPOV	69	CNTR
<3.E−37	−1,2	2–5	70	p	0	[7] ANTIPOV	69B	CNTR
<1.E−35	+1,2	<7	30	p	0	DORFAN	65	CNTR
<2.E−35	−2	< 2.5–5	30	p	0	[8] FRANZINI	65B	CNTR
<5.E−35	+1,2	<2.2	21	p	0	BINGHAM	64	HLBC
<1.E−32	+1,2	<4.0	28	p	0	BLUM	64	HBC
<1.E−35	+1,2	<2.5	31	p	0	[8] HAGOPIAN	64	HBC
<1.E−34	+1	<2	28	p	0	LEIPUNER	64	CNTR
<1.E−33	+1,2	<2.4	24	p	0	MORRISON	64	HBC

[1] ABE 92J flux limits decrease as the mass increases from 50 to 500 GeV. NODE=S027C;LINKAGE=AA

[2] HE 91 limits are for charges of the form $N\pm1/3$ from 23/3 to 38/3. NODE=S027C;LINKAGE=QH

[3] Hadronic or leptonic quarks. NODE=S027C;LINKAGE=C

[4] Cross section cm^2/GeV^2. NODE=S027C;LINKAGE=E

[5] 3×10^{-5} <lifetime $< 1\times10^{-3}$ s. NODE=S027C;LINKAGE=F

[6] Includes BOTT 72 results. NODE=S027C;LINKAGE=D

[7] Assumes isotropic cm production. NODE=S027C;LINKAGE=B

[8] Cross section inferred from flux. NODE=S027C;LINKAGE=A

Quark Differential Production Cross Section — Accelerator Searches

NODE=S027D
NODE=S027D

X-SECT ($cm^2sr^{-1}GeV^{-1}$)	CHG $e/3$	MASS (GeV)	ENERGY (GeV)	BEAM	EVTS	DOCUMENT ID		TECN
<4.E−36	−2,4	1.5–6	70	p	0	BALDIN	76	CNTR
<2.E−33	±4	5–20	52	pp	0	ALBROW	75	SPEC
<5.E−34	<7	7–15	44	pp	0	JOVANOV...	75	CNTR
<5.E−35			20	γ	0	[9] GALIK	74	CNTR
<9.E−35	−1,2		200	p	0	NASH	74	CNTR
<4.E−36	−4	2.3–2.7	70	p	0	ANTIPOV	71	CNTR
<3.E−35	±1,2	<2.7	27	p	0	ALLABY	69B	CNTR
<7.E−38	−1,2	<2.5	70	p	0	ANTIPOV	69B	CNTR

[9] Cross section in cm^2/sr/equivalent quanta. NODE=S027D;LINKAGE=A

Quark Flux — Accelerator Searches

NODE=S027FR
NODE=S027FR

The definition of FLUX depends on the experiment

(a) is the ratio of measured free quarks to predicted free quarks if there is no "confinement."

(b) is the probability of fractional charge on nuclear fragments. Energy is in GeV/nucleon.

(c) is the 90%CL upper limit on fractionally-charged particles produced per interaction.

(d) is quarks per collision.

(e) is inclusive quark-production cross-section ratio to $\sigma(e^+e^- \rightarrow \mu^+\mu^-)$.

(f) is quark flux per charged particle.

(g) is the flux per ν-event.

(h) is quark yield per π^- yield.

(i) is 2-body exclusive quark-production cross-section ratio to $\sigma(e^+e^- \rightarrow \mu^+\mu^-)$.

NODE=S027FR

FLUX		CHG (e/3)	MASS (GeV)	ENRGY (GeV)	BEAM	EVTS	DOCUMENT ID			TECN	
<1.6E−3	b	see note		200	^{32}S–Pb	0	[10] HUENTRUP	96		PLAS	
<6.2E−4	b	see note		10.6	^{32}S–Pb	0	[10] HUENTRUP	96		PLAS	OCCUR=2
<0.94E−4	e	±2	2–30	88–94	e^+e^-	0	AKERS	95R		OPAL	OCCUR=2
<1.7E−4	e	±2	30–40	88–94	e^+e^-	0	AKERS	95R		OPAL	OCCUR=3
<3.6E−4	e	±4	5–30	88–94	e^+e^-	0	AKERS	95R		OPAL	OCCUR=4
<1.9E−4	e	±4	30–45	88–94	e^+e^-	0	AKERS	95R		OPAL	OCCUR=5
<2.E−3	e	+1	5–40	88–94	e^+e^-	0	[11] BUSKULIC	93C		ALEP	
<6.E−4	e	+2	5–30	88–94	e^+e^-	0	[11] BUSKULIC	93C		ALEP	OCCUR=2
<1.2E−3	e	+4	15–40	88–94	e^+e^-	0	[11] BUSKULIC	93C		ALEP	OCCUR=3
<3.6E−4	i	+4	5.0–10.2	88–94	e^+e^-	0	BUSKULIC	93C		ALEP	OCCUR=4
<3.6E−4	i	+4	16.5–26.0	88–94	e^+e^-	0	BUSKULIC	93C		ALEP	OCCUR=5
<6.9E−4	i	+4	26.0–33.3	88–94	e^+e^-	0	BUSKULIC	93C		ALEP	OCCUR=6
<9.1E−4	i	+4	33.3–38.6	88–94	e^+e^-	0	BUSKULIC	93C		ALEP	OCCUR=7
<1.1E−3	i	+4	38.6–44.9	88–94	e^+e^-	0	BUSKULIC	93C		ALEP	OCCUR=8
<1.6E−4	b	see note		see note		0	[12] CECCHINI	93		PLAS	
	b	4,5,7,8		2.1A	^{16}O	0,2,0,6	[13] GHOSH	92		EMUL	
<6.4E−5	g	1			$\nu,\overline{\nu}$	1	[14] BASILE	91		CNTR	
<3.7E−5	g	2			$\nu,\overline{\nu}$	0	[14] BASILE	91		CNTR	OCCUR=2
<3.9E−5	g	1			$\nu,\overline{\nu}$	1	[15] BASILE	91		CNTR	OCCUR=3
<2.8E−5	g	2			$\nu,\overline{\nu}$	0	[15] BASILE	91		CNTR	OCCUR=4
<1.9E−4	c			14.5A	^{28}Si–Pb	0	[16] HE	91		PLAS	
<3.9E−4	c			14.5A	^{28}Si–Cu	0	[16] HE	91		PLAS	OCCUR=2
<1.E−9	c	±1,2,4		14.5A	^{16}O–Ar	0	MATIS	91		MDRP	
<5.1E−10	c	±1,2,4		14.5A	^{16}O–Hg	0	MATIS	91		MDRP	OCCUR=2
<8.1E−9	c	±1,2,4		14.5A	Si–Hg	0	MATIS	91		MDRP	OCCUR=3
<1.7E−6	c	±1,2,4		60A	^{16}O–Hg	0	MATIS	91		MDRP	OCCUR=4
<3.5E−7	c	±1,2,4		200A	^{16}O–Hg	0	MATIS	91		MDRP	OCCUR=5
<1.3E−6	c	±1,2,4		200A	S–Hg	0	MATIS	91		MDRP	OCCUR=6
<5E−2	e	2	19–27	52–60	e^+e^-	0	ADACHI	90C		TOPZ	
<5E−2	e	4	<24	52–60	e^+e^-	0	ADACHI	90C		TOPZ	OCCUR=2
<1.E−4	e	+2	<3.5	10	e^+e^-	0	BOWCOCK	89B		CLEO	
<1.E−6	d	±1,2		60	^{16}O–Hg	0	CALLOWAY	89		MDRP	
<3.5E−7	d	±1,2		200	^{16}O–Hg	0	CALLOWAY	89		MDRP	OCCUR=2
<1.3E−6	d	±1,2		200	S–Hg	0	CALLOWAY	89		MDRP	OCCUR=3
<1.2E−10	d	±1	1	800	p–Hg	0	MATIS	89		MDRP	
<1.1E−10	d	±2	1	800	p–Hg	0	MATIS	89		MDRP	OCCUR=2
<1.2E−10	d	±1	1	800	p–N_2	0	MATIS	89		MDRP	OCCUR=3
<7.7E−11	d	±2	1	800	p–N_2	0	MATIS	89		MDRP	OCCUR=4
<6.E−9	h	−5	0.9–2.3	12	p	0	NAKAMURA	89		SPEC	
<5.E−5	g	1,2	<0.5		$\nu,\overline{\nu}\,d$	0	ALLASIA	88		BEBC	
<3.E−4	b	See note		14.5	^{16}O–Pb	0	[17] HOFFMANN	88		PLAS	
<2.E−4	b	See note		200	^{16}O–Pb	0	[18] HOFFMANN	88		PLAS	OCCUR=2
<8E−5	b	19,20,22,23		200A			GERBIER	87		PLAS	
<2.E−4	a	±1,2	<300	320	$\overline{p}p$	0	LYONS	87		MLEV	
<1.E−9	c	±1,2,4,5		14.5	^{16}O–Hg	0	SHAW	87		MDRP	
<3.E−3	d	−1,2,3,4,6	<5	2	Si–Si	0	[19] ABACHI	86C		CNTR	
<1.E−4	e	±1,2,4	<4	10	e^+e^-	0	ALBRECHT	85G		ARG	
<6.E−5	b	±1,2	1	540	$p\overline{p}$	0	BANNER	85		UA2	
<5.E−3	e	−4	1–8	29	e^+e^-	0	AIHARA	84		TPC	
<1.E−2	e	±1,2	1–13	29	e^+e^-	0	AIHARA	84B		TPC	
<2.E−4	b	±1		72	^{40}Ar	0	[20] BARWICK	84		CNTR	
<1.E−4	e	±2	<0.4	1.4	e^+e^-	0	BONDAR	84		OLYA	
<5.E−1	e	±1,2	<13	29	e^+e^-	0	GURYN	84		CNTR	
<3.E−3	b	±1,2	<2	540	$p\overline{p}$	0	BANNER	83		CNTR	
<1.E−4	b	±1,2		106	^{56}Fe	0	LINDGREN	83		CNTR	
<3.E−3	b	$>\lvert\pm 0.1\rvert$		74	^{40}Ar	0	[20] PRICE	83		PLAS	
<1.E−2	e	±1,2	<14	29	e^+e^-	0	MARINI	82B		CNTR	
<8.E−2	e	±1,2	<12	29	e^+e^-	0	ROSS	82		CNTR	

<3.E−4	e	±2	1.8–2	7	e^+e^-	0		WEISS	81	MRK2
<5.E−2	e	+1,2,4,5	2–12	27	e^+e^-	0		BARTEL	80	JADE
<2.E−5	g	1,2			ν	0	[14,15]	BASILE	80	CNTR
<3.E−10	f	±2,4	1–3	200	p	0	[21]	BOZZOLI	79	CNTR
<6.E−11	f	±1	<21	52	pp	0		BASILE	78	SPEC
<5.E−3	g				ν_μ	0		BASILE	78B	CNTR
<2.E−9	f	±1	<26	62	pp	0		BASILE	77	SPEC
<7.E−10	f	+1,2	<20	52	p	0	[22]	FABJAN	75	CNTR
		+1,2	>4.5		γ	0	[14,15]	GALIK	74	CNTR
		+1,2	>1.5	12	e^-	0	[14,15]	BELLAMY	68	CNTR
		+1,2	>0.9		γ	0	[15]	BATHOW	67	CNTR
		+1,2	>0.9	6	γ	0	[15]	FOSS	67	CNTR

[10] HUENTRUP 96 quote 95% CL limits for production of fragments with charge differing by as much as $\pm 1/3$ (in units of e) for charge $6 \leq Z \leq 10$.
NODE=S027FR;LINKAGE=K

[11] BUSKULIC 93C limits for inclusive quark production are more conservative if the ALEPH hadronic fragmentation function is assumed.
NODE=S027FR;LINKAGE=G

[12] CECCHINI 93 limit at 90%CL for $23/3 \leq Z \leq 40/3$, for 16A GeV O, 14.5A Si, and 200A S incident on Cu target. Other limits are 2.3×10^{-4} for $17/3 \leq Z \leq 20/3$ and 1.2×10^{-4} for $20/3 \leq Z \leq 23/3$.
NODE=S027FR;LINKAGE=Q1

[13] GHOSH 92 reports measurement of spallation fragment charge based on ionization in emulsion. Out of 650 measured tracks, 2 were consistent with charge $5e/3$, and 4 with $7e/3$.
NODE=S027FR;LINKAGE=H

[14] Hadronic quark.
NODE=S027FR;LINKAGE=B

[15] Leptonic quark.
NODE=S027FR;LINKAGE=A

[16] HE 91 limits are for charges of the form $N \pm 1/3$ from 23/3 to 38/3, and correspond to cross-section limits of 380μb (Pb) and 320μb (Cu).
NODE=S027FR;LINKAGE=QH

[17] The limits apply to projectile fragment charges of 17, 19, 20, 22, 23 in units of $e/3$.
NODE=S027FR;LINKAGE=H1

[18] The limits apply to projectile fragment charges of 16, 17, 19, 20, 22, 23 in units of $e/3$.
NODE=S027FR;LINKAGE=H2

[19] Flux limits and mass range depend on charge.
NODE=S027FR;LINKAGE=F

[20] Bound to nuclei.
NODE=S027FR;LINKAGE=I

[21] Quark lifetimes $> 1 \times 10^{-8}$ s.
NODE=S027FR;LINKAGE=D

[22] One candidate m <0.17 GeV.
NODE=S027FR;LINKAGE=C

Quark Flux — Cosmic Ray Searches

NODE=S027F

Shielding values followed with an asterisk indicate altitude in km. Shielding values not followed with an asterisk indicate sea level in kg/cm^2.
NODE=S027F

FLUX ($cm^{-2}sr^{-1}s^{-1}$)	CHG ($e/3$)	MASS (GeV)	SHIELDING	EVTS		DOCUMENT ID		TECN	
< 9.2E−15	±1		3800	0	[23]	AMBROSIO	00C	MCRO	
<2.1E−15	±1			0		MORI	91	KAM2	
<2.3E−15	±2			0		MORI	91	KAM2	OCCUR=2
<2.E−10	±1,2		0.3	0		WADA	88	CNTR	
	±4		0.3	12	[24]	WADA	88	CNTR	OCCUR=3
	±4		0.3	9	[25]	WADA	86	CNTR	
<1.E−12	±2,3/2		−70.	0	[26]	KAWAGOE	84B	PLAS	
<9.E−10	±1,2		0.3	0		WADA	84B	CNTR	
<4.E−9	±4		0.3	7		WADA	84B	CNTR	OCCUR=2
<2.E−12	±1,2,3		−0.3 *	0		MASHIMO	83	CNTR	
<3.E−10	±1,2		0.3	0		MARINI	82	CNTR	
<2.E−11	±1,2			0		MASHIMO	82	CNTR	
<8.E−10	±1,2		0.3	0	[26]	NAPOLITANO	82	CNTR	
				3	[27]	YOCK	78	CNTR	
<1.E−9				0	[28]	BRIATORE	76	ELEC	
<2.E−11	+1			0	[29]	HAZEN	75	CC	
<2.E−10	+1,2			0		KRISOR	75	CNTR	
<1.E−7	+1,2			0	[29,30]	CLARK	74B	CC	
<3.E−10	+1	>20		0		KIFUNE	74	CNTR	
<8.E−11	+1			0	[29]	ASHTON	73	CNTR	
<2.E−8	+1,2			0		HICKS	73B	CNTR	
<5.E−10	+4		2.8 *	0		BEAUCHAMP	72	CNTR	
<1.E−10	+1,2			0	[29]	BOHM	72B	CNTR	
<1.E−10	+1,2		2.8 *	0		COX	72	ELEC	
<3.E−10	+2			0		CROUCH	72	CNTR	
<3.E−8			7	0	[28]	DARDO	72	CNTR	
<4.E−9	+1			0	[29]	EVANS	72	CC	
<2.E−9		>10		0	[28]	TONWAR	72	CNTR	
<2.E−10	+1		2.8 *	0		CHIN	71	CNTR	
<3.E−10	+1,2			0	[29]	CLARK	71B	CC	

<1.E−10	+1,2			0	[29]	HAZEN	71	CC
<5.E−10	+1,2		3.5 *	0		BOSIA	70	CNTR
	+1,2	<6.5		1	[29]	CHU	70	HLBC
<2.E−9	+1			0		FAISSNER	70B	CNTR
<2.E−10	+1,2		0.8 *	0		KRIDER	70	CNTR
<5.E−11	+2			4		CAIRNS	69	CC
<8.E−10	+1,2	<10		0		FUKUSHIMA	69	CNTR
	+2			1	[29,31]	MCCUSKER	69	CC
<1.E−10		>5	1.7,3.6	0	[28]	BJORNBOE	68	CNTR
<1.E−8	±1,2,4		6.3,.2 *	0	[26]	BRIATORE	68	CNTR
<3.E−8		>2		0		FRANZINI	68	CNTR
<9.E−11	±1,2			0		GARMIRE	68	CNTR
<4.E−10	±1			0		HANAYAMA	68	CNTR
<3.E−8		>15		0		KASHA	68	OSPK
<2.E−10	+2			0		KASHA	68B	CNTR
<2.E−10	+4			0		KASHA	68C	CNTR
<2.E−10	+2		6	0		BARTON	67	CNTR
<2.E−7	+4		0.008,0.5 *	0		BUHLER	67	CNTR
<5.E−10	1,2		0.008,0.5 *	0		BUHLER	67B	CNTR
<4.E−10	+1,2			0		GOMEZ	67	CNTR
<2.E−9	+2			0		KASHA	67	CNTR
<2.E−10	+2		220	0		BARTON	66	CNTR
<2.E−9	+1,2		0.5 *	0		BUHLER	66	CNTR
<3.E−9	+1,2			0		KASHA	66	CNTR
<2.E−9	+1,2			0		LAMB	66	CNTR
<2.E−8	+1,2	>7	2.8 *	0		DELISE	65	CNTR
<5.E−8	+2	>2.5	0.5 *	0		MASSAM	65	CNTR
<2.E−8	+1		2.5 *	0		BOWEN	64	CNTR
<2.E−7	+1		0.8	0		SUNYAR	64	CNTR

[23] AMBROSIO 00C limit is below 11×10^{-15} for $0.25 < q/e < 0.5$, and is changing rapidly near q/e=2/3, where it is 2×10^{-14}.
[24] Distribution in celestial sphere was described as anisotropic.
[25] With telescope axis at zenith angle 40° to the south.
[26] Leptonic quarks.
[27] Lifetime $> 10^{-8}$ s; charge ±0.70, 0.68, 0.42; and mass >4.4, 4.8, and 20 GeV, respectively.
[28] Time delayed air shower search.
[29] Prompt air shower search.
[30] Also $e/4$ and $e/6$ charges.
[31] No events in subsequent experiments.

NODE=S027F;LINKAGE=MC
NODE=S027F;LINKAGE=H
NODE=S027F;LINKAGE=G
NODE=S027F;LINKAGE=C
NODE=S027F;LINKAGE=F
NODE=S027F;LINKAGE=A
NODE=S027F;LINKAGE=B
NODE=S027F;LINKAGE=E
NODE=S027F;LINKAGE=D

Quark Density — Matter Searches

NODE=S027RHO
NODE=S027RHO

QUARKS/ NUCLEON	CHG (e/3)	MASS (GeV)	MATERIAL/METHOD	EVTS		DOCUMENT ID		
<1.17E−22			silicone oil drops	0	[32]	LEE	02	
<4.71E−22			silicone oil drops	1	[33]	HALYO	00	
<4.7E−21	±1,2		silicone oil drops	0		MAR	96	
<8.E−22	+2		Si/infrared photoionization	0		PERERA	93	
<5.E−27	±1,2		sea water/levitation	0		HOMER	92	
<4.E−20	±1,2		meteorites/mag. levitation	0		JONES	89	
<1.E−19	±1,2		various/spectrometer	0		MILNER	87	
<5.E−22	±1,2		W/levitation	0		SMITH	87	
<3.E−20	+1,2		org liq/droplet tower	0		VANPOLEN	87	
<6.E−20	−1,2		org liq/droplet tower	0		VANPOLEN	87	OCCUR=2
<3.E−21	±1		Hg drops-untreated	0		SAVAGE	86	
<3.E−22	±1,2		levitated niobium	0		SMITH	86	
<2.E−26	±1,2		^{4}He/levitation	0		SMITH	86B	
<2.E−20	>±1	0.2–250	niobium+tungs/ion	0		MILNER	85	
<1.E−21	±1		levitated niobium	0		SMITH	85	
	+1,2	<100	niobium/mass spec	0		KUTSCHERA	84	
<5.E−22			levitated steel	0		MARINELLI	84	
<9.E−20	± <13		water/oil drop	0		JOYCE	83	
<2.E−21	> | ± 1/2|		levitated steel	0		LIEBOWITZ	83	
<1.E−19	±1,2		photo ion spec	0		VANDESTEEG	83	
<2.E−20			mercury/oil drop	0	[34]	HODGES	81	
1.E−20	+1		levitated niobium	4	[35]	LARUE	81	

1.E−20	−1		levitated niobium	4	[35] LARUE	81	OCCUR=2
<1.E−21			levitated steel	0	MARINELLI	80B	
<6.E−16			helium/mass spec	0	BOYD	79	
1.E−20	+1		levitated niobium	2	[35] LARUE	79	
<4.E−28			earth+/ion beam	0	OGOROD...	79	
<5.E−15	+1		tungs./mass spec	0	BOYD	78	
<5.E−16	+3	<1.7	hydrogen/mass spec	0	BOYD	78B	
<1.E−21	±2,4		water/ion beam	0	LUND	78	
<6.E−15	>1/2		levitated tungsten	0	PUTT	78	
<1.E−22			metals/mass spec	0	SCHIFFER	78	
<5.E−15			levitated tungsten ox	0	BLAND	77	
<3.E−21			levitated iron	0	GALLINARO	77	
2.E−21	−1		levitated niobium	1	[35] LARUE	77	
4.E−21	+1		levitated niobium	2	[35] LARUE	77	OCCUR=2
<1.E−13	+3	<7.7	hydrogen/mass spec	0	MULLER	77	
<5.E−27			water+/ion beam	0	OGOROD...	77	
<1.E−21			lunar+/ion spec	0	STEVENS	76	
<1.E−15	+1	<60	oxygen+/ion spec	0	ELBERT	70	
<5.E−19			levitated graphite	0	MORPURGO	70	
<5.E−23			water+/atom beam	0	COOK	69	
<1.E−17	±1,2		levitated graphite	0	BRAGINSK	68	
<1.E−17			water+/uv spec	0	RANK	68	
<3.E−19	±1		levitated iron	0	STOVER	67	
<1.E−10			sun/uv spec	0	[36] BENNETT	66	
<1.E−17	+1,2		meteorites+/ion beam	0	CHUPKA	66	
<1.E−16	±1		levitated graphite	0	GALLINARO	66	
<1.E−22			argon/electrometer	0	HILLAS	59	
	−2		levitated oil	0	MILLIKAN	10	

[32] 95% CL limit for fractional charge particles with $0.18e \leq |Q_{residual}| \leq 0.82e$ in total of 70.1 mg of silicone oil. NODE=S027RHO;LINKAGE=LE

[33] 95% CL limit for particles with fractional charge $|Q_{residual}|$ >0.16e in total of 17.4 mg of silicone oil. NODE=S027RHO;LINKAGE=HA

[34] Also set limits for $Q = \pm e/6$. NODE=S027RHO;LINKAGE=B

[35] Note that in PHILLIPS 88 these authors report a subtle magnetic effect which could account for the apparent fractional charges. NODE=S027RHO;LINKAGE=C

[36] Limit inferred by JONES 77B. NODE=S027RHO;LINKAGE=A

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LEE	02	PR D66 012002	I.T. Lee *et al.*		REFID=48804
AMBROSIO	00C	PR D62 052003	M. Ambrosio *et al.*	(MACRO Collab.)	REFID=47695
HALYO	00	PRL 84 2576	V. Halyo *et al.*		REFID=47600
ABREU	97D	PL B396 315	P. Abreu *et al.*	(DELPHI Collab.)	REFID=45316
HUENTRUP	96	PR C53 358	G. Huentrup *et al.*	(SIEG)	REFID=44744
MAR	96	PR D53 6017	N.M. Mar *et al.*	(SLAC, SCHAF, LANL, UCI)	REFID=44785
AKERS	95R	ZPHY C67 203	R. Akers *et al.*	(OPAL Collab.)	REFID=44370
BUSKULIC	93C	PL B303 198	D. Buskulic *et al.*	(ALEPH Collab.)	REFID=43295
CECCHINI	93	ASP 1 369	S. Cecchini *et al.*		REFID=45968
PERERA	93	PRL 70 1053	A.G.U. Perera *et al.*	(PITT)	REFID=43207
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GHOSH	92	NC 105A 99	D. Ghosh *et al.*	(JADA, BANGB)	REFID=42041
HOMER	92	ZPHY C55 549	G.J. Homer *et al.*	(RAL, SHMP, LOQM)	REFID=42203
BASILE	91	NC 104A 405	M. Basile *et al.*	(BGNA, INFN, CERN, PLRM+)	REFID=41493
HE	91	PR C44 1672	Y.B. He, P.B. Price	(UCB)	REFID=41602
MATIS	91	NP A525 513c	H.S. Matis *et al.*	(LBL, SFSU, UCI+)	REFID=41512
MORI	91	PR D43 2843	M. Mori *et al.*	(Kamiokande II Collab.)	REFID=41501
ADACHI	90C	PL B244 352	I. Adachi *et al.*	(TOPAZ Collab.)	REFID=41322
BOWCOCK	89B	PR D40 263	T.J.V. Bowcock *et al.*	(CLEO Collab.)	REFID=40872
CALLOWAY	89	PL B232 549	D. Calloway *et al.*	(SFSU, UCI, LBL+)	REFID=41274
JONES	89	ZPHY C43 349	W.G. Jones *et al.*	(LOIC, RAL)	REFID=40858
MATIS	89	PR D39 1851	H.S. Matis *et al.*	(LBL, SFSU, UCI+)	REFID=40840
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LYONS	87	ZPHY C36 363	L. Lyons *et al.*	(OXF, RAL, LOIC)	REFID=40482
MILNER	87	PR D36 37	R.E. Milner *et al.*	(CIT)	REFID=40479
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ALBRECHT	85G	PL 156B 134	H. Albrecht *et al.*	(ARGUS Collab.)	REFID=12204
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KAWAGOE	84B	LNC 41 604	K. Kawagoe *et al.* (TOKY)	REFID=12214
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